IAP20 Rec'd PCT/PTO 25 MAY 2006

BEARING APPARATUS FOR A WHEEL OF VEHICLE

BACKGROUND OF THE INVENTION

【0001】

Field of the Invention

The present invention relates to a bearing apparatus for a wheel of vehicle and more particularly to improvements in mounting structures a wheel bearing.

【0002】

Description of Background Art

A bearing apparatus 80 for a wheel of vehicle of the prior art comprises, as shown in Fig. 14, a hub wheel 81 for securing thereon a brake rotor 87 and a wheel (not shown), a wheel bearing 84 including an outer ring 82 and a pair of inner rings 83 for rotatably supporting the hub wheel 81, a knuckle 85 for supporting the wheel bearing 84 on a body of vehicle, and a constant velocity universal joint 86 adapted to be connected to the hub wheel 81 for transmitting the power from a driving shaft (not shown) to the hub wheel 81.

【0003】

Although there has been used for parts forming the bearing apparatus 80, especially for the knuckle 85 ferrous metal such as malleable cast iron having substantially same coefficient of linear thermal expansion as that of material forming the hub wheel 81 etc. it is a recent tendency of adopting light metal alloy such as aluminum alloy in place of ferrous metal to reduce the weight of a vehicle. However it is a problem that the outer ring 82 of the wheel bearing 84 would be released from the knuckle 85 with reduction of force interference fit caused by temperature rise during travel of vehicle due to difference of the coefficient of linear thermal expansion between the knuckle 85 and the outer ring 82 if the knuckle 85 is made of such light metal alloy. As the result of which

there are sometimes caused troubles such as loss of preload and thus the preload of the wheel bearing set at its assembly cannot be maintained.

【0004】

In addition there are caused other problems such as generation of creep or seizing of the outer ring 82 which would cause reduction of the life of the wheel bearing. The creep in the outer ring 82 means a phenomenon in which the interference fitting surface of the outer ring 82 is mirror finished by circumferential micro-movement of the outer ring 82 due to lack of interference fitting force or finishing accuracy of the outer ring 82 which would cause seizing or melting thereof.

【0005】

In order to avoid these problems, it has been carried out in the bearing apparatus 80 of the prior art that the initial value of preload is set high to ensure the preload of the wheel bearing 84 in case of temperature rise and the initial interference is set large in anticipation of reduction of interference in case of temperature rise to prevent the creep. Since these prior arts are those carried out in practice and not disclosed in any document, no prior art disclosed in any document exists.

SUMMARY OF THE INVENTION

Disclosure of the Invention

Problems to be solved by the Invention

【0006】

However if the initial amount of the preload of the wheel bearing 84 is set high, the wheel bearing is always obliged to be excessively loaded and thus the life is reduced. In addition the rigidity of the bearing is varied by a large variation of the amount of the preload due to temperature variation and this would cause an adverse influence to the running stability of vehicle. Furthermore, if the initial interference is set large, it is necessary to press-fit

the wheel bearing 84 by preheating the knuckle 85 to prevent generation of galling in the knuckle 85 during press-fitting of the wheel bearing 84. This increases the assembling step and thus manufacturing cost.

【0007】

It is, therefore, an object of the present invention to provide a bearing apparatus for a wheel of vehicle which can be press-fitted into a knuckle of light metal alloy intended to reduce its weight as well as can prevent the reduction of preload and generation of creep in the wheel bearing due to temperature rise.

Means for solving the problems

【0008】

For achieving the object of the present invention, there is provided, according to claim 1, a bearing apparatus for a wheel of vehicle comprising a hub wheel having a wheel mounting flange integrally formed therewith at its one end and an axially extending cylindrical portion of a smaller diameter; a wheel bearing including a double row rolling bearing arranged on the cylindrical portion; and a knuckle of light metal, wherein the wheel bearing is press-fitted into the knuckle via a predetermined interference and the hub wheel is rotatably supported relative to the knuckle via the wheel bearing characterized in that at least one of an inner circumferential surface of an inner ring and an outer circumferential surface of an outer ring of the wheel bearing is formed with an annular groove (or grooves) and each annular groove is filled with a resin band of heat resisting synthetic resin formed by injection molding.

【0009】

According to the present invention of claim 1, since at least one of an inner circumferential surface of an inner ring and an outer circumferential surface of an outer ring of the wheel bearing formed with an annular groove (or grooves) and each annular groove is filled with a resin band of heat resisting synthetic resin formed by injection molding, it is possible to suppress the reduction of fitting interference, to prevent the generation of creep as well as reduction of

the initially set preload, and also to securely keep the running stability of vehicle by suppressing the variation of rigidity of the bearing.

【0010】

According to the present invention of claim 2, each resin band is made of synthetic resin of polyamide family having the coefficient of linear thermal expansion of $(8\sim16)\times10^{-5}$/℃. Since the resin band has the coefficient of linear thermal expansion larger than that of the knuckle, the resin band can follow the variation of thermal expansion of the knuckle even though the knuckle is thermally expanded larger than that of the outer ring of the wheel bearing.

【0011】

According to the present invention of claim 3, each resin band is formed so that it projects from the circumferential surface of the inner and/or outer rings. Thus it is possible to securely prevent the reduction of the interference due to temperature rise, to suppress the reduction of the rigidity of the resin band and thus to prevent breakage of the resin band during its press-fitting.

【0012】

According to the present invention of claim 4, each annular groove is formed in a load supporting region of the inner or outer ring. This enables to effectively prevent the loss of preload and the generation of creep in the bearing.

【0013】

According to the present invention of claim 5, each annular groove is formed as an eccentric groove of which center is offset a predetermined amount from the central axis of the wheel bearing. This enables to securely prevent the relative rotation between the resin band and the inner or outer ring by a simple structure.

【0014】

According to the present invention of claim 6, the wheel bearing is secured with being sandwiched between the hub wheel and a shoulder of an outer joint member forming a constant velocity universal joint via disc shaped expansion

compensating members made of heat resisting synthetic resin, and wherein a predetermined preload is applied to the wheel bearing. Thus it is possible to keep the initial preload of the bearing within a predetermined range for a long term without any change of specification of the bearing apparatus of the prior art.

【0015】

According to the present invention of claim 7, an annular groove is formed on each end face of larger diameter of the inner ring and the annular groove is filled with the expansion compensating member formed by injection molding. Thus it is possible to prevent the reduction of the initially set preload of the bearing and to improve the bearing assembling efficiency.

Effect of the Invention

【0016】

The bearing apparatus for a wheel of vehicle of the present invention comprises a hub wheel having a wheel mounting flange integrally formed therewith at its one end and an axially extending cylindrical portion of a smaller diameter; a wheel bearing including a double row rolling bearing arranged on the cylindrical portion; and a knuckle of light metal, wherein the wheel bearing is press-fitted into the knuckle via a predetermined interference and the hub wheel is rotatably supported relative to the knuckle via the wheel bearing characterized in that at least one of an inner circumferential surface of an inner ring and an outer circumferential surface of an outer ring of the wheel bearing is formed with an annular groove (or grooves) and each annular groove is filled with a resin band of heat resisting synthetic resin formed by injection molding. Thus it is possible to suppress the reduction of fitting interference, to prevent the generation of creep as well as reduction of the initially set preload, and also to securely keep the running stability of vehicle by suppressing the variation of rigidity of the bearing.

【Best mode for carrying out the invention】

【0017】

The best mode for carrying out the present invention is a bearing apparatus for a wheel of vehicle comprising a hub wheel having a wheel mounting flange integrally formed therewith at its one end and an axially extending cylindrical portion of a smaller diameter; a wheel bearing including a double row rolling bearing arranged on the cylindrical portion; and a knuckle of light metal, wherein the wheel bearing is press-fitted into the knuckle via a predetermined interference and the hub wheel is rotatably supported relative to the knuckle via the wheel bearing characterized in that at least one of an inner circumferential surface of an inner ring and an outer circumferential surface of an outer ring of the wheel bearing is formed with an annular groove (or grooves), each annular groove is filled with a resin band of heat resisting synthetic resin formed by injection molding, and each resin band is made of synthetic resin of polyamide family having the coefficient of linear thermal expansion of $(8\sim16)\times10^{-5}/℃$.

BRIEF DESCRIPTION OF THE DRAWINGS

Additional advantages and features of the present invention will become apparent from the subsequent description and the appended claims, taken in conjunction with the accompanying drawings, wherein:

Fig. 1 is a longitudinal section view showing a first embodiment of the bearing apparatus for a wheel of vehicle of the present invention;

Fig. 2 is a longitudinal section view showing a wheel bearing used in the bearing apparatus of the first embodiment;

Fig. 3 is a graph showing a relation between the temperature variation and the of bearing preload as to wheel bearings of the prior art and the present invention;

Fig. 4 is a longitudinal section view showing a second embodiment of the bearing apparatus for a wheel of vehicle of the present invention;

Fig. 5 is a longitudinal section view showing a third embodiment of the bearing apparatus for a wheel of vehicle of the present invention;

Fig. 6 is a longitudinal section view showing a wheel bearing used in the bearing apparatus of the third embodiment;

Fig. 7 is a longitudinal section view showing a wheel bearing used in the bearing apparatus of the fourth embodiment;

Fig. 8 is a longitudinal section view showing a wheel bearing used in the bearing apparatus of the fifth embodiment;

Fig. 9 is a longitudinal section view showing a wheel bearing used in the bearing apparatus of the sixth embodiment;

Fig. 10 is a longitudinal section view showing a wheel bearing used in the bearing apparatus of the seventh embodiment;

Fig. 11 is a longitudinal section view showing a wheel bearing used in the bearing apparatus of the eighth embodiment;

Fig. 12 is a longitudinal section view showing a ninth embodiment of the bearing apparatus for a wheel of vehicle of the present invention;

Fig. 13 is a longitudinal section view showing a tenth embodiment of the bearing apparatus for a wheel of vehicle of the present invention; and

Fig. 14 is a longitudinal section view showing the bearing apparatus for a wheel of vehicle of the prior art.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

<u>First embodiment</u>

【0018】

Preferable embodiments of the present invention will be hereinafter described with reference to the drawings.

Fig. 1 shows a first embodiment of a bearing apparatus for a wheel of vehicle of the present invention. In the description below, a term “outboard side” of the apparatus denotes a side which is positioned outside of the vehicle body and a

term "inboard side" of the apparatus denotes a side which is positioned inside of the body when the bearing apparatus is mounted on the vehicle body.

【0019】

The bearing apparatus for a wheel of vehicle of the present invention shown in Fig. 1 comprises, as main components, a hub wheel 1, and a wheel bearing 3 for rotatably supporting the hub wheel 1 relative to a knuckle 2. The hub wheel 1 is made of medium carbon steel including carbon of 0.40～0.80%by weight such as S53C and comprises a wheel mounting flange 4 for mounting a wheel "W" and a brake rotor "B" at an end of outboard side, and a cylindrical portion 5 of smaller diameter axially extending from the wheel mounting flange 4. Hub bolts 4a for securing the wheel "W" and the brake rotor "B" are secured on the wheel mounting flange 4 at an equidistant interval along its circumferential direction. A serration (or spline) 6 is on an inner circumferential surface of the hub wheel 1 and the wheel bearing 3 is press-fitted on the outer circumferential surface of the cylindrical portion 5.

【0020】

The wheel bearing 3 press-fitted onto the cylindrical portion 5 of the hub wheel 1 is secured with being sandwiched between the hub wheel 1 and a shoulder 9 of an outer joint member 8 forming a constant velocity universal joint 7. The outer joint member 8 is integrally formed with a stem portion 10 axially extending from the shoulder 9. A serration (or spline) 10a engaging the serration 6 of the hub wheel 1 and a threaded portion 10b are formed on the outer circumferential surface of the stem 10 and thus a torque from an engine can be transmitted to the hub wheel 1 via a drive shaft (not shown), the constant velocity universal joint 7, and the serrated portions 6 and 10a.

【0021】

The serration 10a is provided with a helix angle inclined a predetermined angle relative to the central axis of the stem portion 10 and thus the serrated portion 10a of helix angle is press-fitted into the serrated portion 6 of the hub

wheel 1 until the shoulder 9 of the outer joint member 8 abuts the wheel bearing 3. Accordingly, a circumferential rattle between the serrated portions 6 and 10a are cancelled by applying the preload therebetween. In addition, it is designed that a desirable bearing preload can be obtained by fastening a securing nut 11 with a predetermined fastening torque onto the threaded portion 10b formed on the end of the stem portion 10. That is, The wheel bearing 3 is press-fitted with a predetermined interference so as to prevent the bearing creep from being caused on the bearing relative to the hub wheel 1 and to obtain a desired amount of preload. On the other hand, the knuckle 2 is formed of light metal such as aluminum alloy. Thus the weight of the knuckle 2 can be reduced to half the weight of a knuckle made of cast iron although the thickness of the knuckle of light metal is increased so as to make up deficiency of its rigidity. The wheel bearing 3 is press-fitted into the knuckle 2.

【0022】

As shown in Fig. 2, the wheel bearing 3 is made of high carbon chrome bearing steel such as SUJ2 and has an outer ring 12, one pair of inner rings 13, and a double row rolling elements (balls) 14. A double row outer raceway surfaces 12a are formed on the inner circumferential surface of the outer ring 12. On the other hand, an inner raceway surface 13a is formed on each outer circumferential surface of each inner ring 13 arranged oppositely to each of the outer raceway surface 12a. The double row rolling elements (balls) 14 are rollably contained by cages 15 between these outer and inner raceway surfaces 12a and 13a. Seals 16 and 17 are arranged at either ends of the wheel bearing 3 to prevent grease contained within the bearing 3 from being leaked therefrom as well as rain water and dusts from being entered to the bearing 3.

【0023】

A pair of annular grooves 18 are formed on the outer circumferential surface of the outer ring 12. These annular grooves 18 are arranged at positions corresponding to the bottoms of the outer raceway surfaces 12a or close to these

bottoms, that is load supporting areas. Thus the loss of preload and the bearing creep can be effectively prevented. Each of the annular grooves 18 is filled with a resin band 19 formed by injection molding PA11 (polyamide11) based heat resisting thermoplastic synthetic resin. The outer diameter of the resin band 19 is projected from that of the outer ring 12 by 0～50 μ m. It is difficult to securely prevent the reduction of interference due to temperature rise if the projected amount is less than 0, on the other hand, damages such as gouge tend to be caused on the resin band 19 during its press-fitting into the knuckle 2 if the projected amount exceeds 50 μ m. Although the projected amount is determined based on the size of the bearing, it is preferable to set the projected amount within a range of 10～40 μ m in consideration of dispersion of manufacture.

【0024】

The material of the resin band 19 is not limited to PA11 and any synthetic resin may be used if it has the coefficient of linear thermal expansion ((8～16) $\times 10^{-5}$/℃) larger than that ((2～2.3) $\times 10^{-5}$/℃) of the knuckle 2 of light metal such as aluminum alloy. Examples of the resin band 19 include PA66 and composite material of thermoplastic resin and reinforcing fibers such as GF (glass fibers) contained therein by a range 10～30%by weight. It is preferable that each annular groove 18 is formed as an eccentric groove of which center is offset a predetermined amount from the central axis of the wheel bearing 3 in order to prevent the resin band 10 from being rotated relative to the outer ring 12.

【0025】

Fig. 3 is a graph showing a relation between the temperature variation and the bearing preload i.e. the temperature variation and dimensional variation of the outer raceway surfaces 12a of the outer ring 12 measured under a condition in which only the outer ring of the wheel bearings of the prior art and the present invention is press-fitted into the knuckle of aluminum alloy. It will be appreciated from this graph that although the bearing preload is linearly

reduced corresponding to the temperature rise in the outer ring of the prior art, the bearing preload in the outer ring of the present invention is more gradually reduced than that of the prior art toward a temperature of about 80℃ and thereafter a predetermined amount of preload can be maintained.

【0026】

As described above, according to the present invention since the knuckle 2 is formed of light metal such as aluminum alloy and resin bands 19 having the coefficient of linear thermal expansion larger than that of the knuckle 2 are formed on the outer circumferential surface of the outer ring 12 of the wheel bearing 3 press-fitted into the knuckle 2, it is possible to suppress the reduction of the fitting interference, to prevent the generation of the bearing creep, and to securely keep the running stability of vehicle with suppressing the variation of bearing rigidity although the knuckle 2 would be thermally expanded larger than the outer ring itself of the wheel bearing 3 during temperature rise.

【0027】

In addition it is possible, by applying the present invention to a wheel bearing apparatus of first generation type, to keep characteristic features such as standardization and general utility of bearings, etc., to improve the running stability of vehicle with suppressing the variation of bearing rigidity even if the bearing has relatively small rigidity, and also to keep the initial bearing preload at a predetermined range for a long term without changing the specifications of the wheel bearing apparatus of the prior art.

Second embodiment

【0028】

Fig. 4 is a longitudinal view showing a second embodiment of the bearing apparatus for a wheel of the present invention. This embodiment is different from the first embodiment only in the structure of the outer ring and thus same reference numerals are used for designating same parts having same functions used in the first embodiment.

【0029】

In this wheel bearing 20, a single annular groove 22 is formed on the outer circumferential surface of the outer ring 21. The annular groove 22 is formed at the axially center of the outer circumferential surface of the outer ring 21 so that it spans the double row outer raceway surfaces 12a. The annular groove 22 is filled with the resin band 23 formed by injection molding PA11 (polyamide11) based heat resisting thermoplastic synthetic resin.

【0030】

Since the resin band 23 of this second embodiment is formed by same manner as that of the first embodiment, it is also possible to suppress the reduction of the fitting interference, to prevent the generation of the bearing creep, and to securely keep the running stability of vehicle with suppressing the variation of bearing rigidity although the knuckle 2 would be thermally expanded larger than the outer ring itself of the wheel bearing 20 during temperature rise.

Third embodiment

【0031】

Fig. 5 is a longitudinal view showing a third embodiment of the bearing apparatus for a wheel of the present invention. This embodiment is different from the first embodiment only in the structure of the wheel bearing and thus same reference numerals are used for designating same parts having same functions used in the first embodiment.

【0032】

In this bearing apparatus for a wheel of vehicle, the wheel bearing 24 is press-fitted onto the cylindrical portion 5 of the hub wheel 1 and secured with being sandwiched between the hub wheel 1 and a shoulder 9 of an outer joint member 8. A desirable bearing preload can be obtained by fastening the securing nut 11 with a predetermined fastening torque onto the threaded portion 10b formed on the end of the stem portion 10. The wheel bearing 24 is

press-fitted with a predetermined interference into the knuckle 2 formed of light metal such as aluminum alloy.

【0033】

As shown in Fig. 6, the wheel bearing 24 has an outer ring 25, one pair of inner rings 26, and a double row rolling elements (conical rollers) 27. A double row outer raceway surfaces 25a are formed on the inner circumferential surface of the outer ring 25. On the other hand, an inner raceway surface 26a is formed on each outer circumferential surface of each inner ring 26 arranged oppositely to each of the outer raceway surface 25a. The double row rolling elements 27 are rollably contained by cages 28 between these outer and inner raceway surfaces 25a and 26a and guided by larger flanges 26b. Seals 16 are arranged at either ends of the wheel bearing 24 to prevent grease contained within the bearing 24 from being leaked therefrom as well as rain water and dusts from being entered to the bearing 24.

【0034】

A pair of annular grooves 18 are formed on the outer circumferential surface of the outer ring 25. These annular grooves 18 are arranged at load supporting areas of the double row outer raceway surfaces 25a. Each of the annular grooves 18 is filled with a resin band 19 formed by injection molding PA11 (polyamide11) based heat resisting thermoplastic synthetic resin.

【0035】

In the wheel bearing 24 comprising the double row conical rollers, the rolling elements (conical rollers) 27 contact the inner and outer raceway surfaces 26a and 25a in a line contact manner and thus a larger load supporting capacity can be obtained as compared with the previously mentioned double row angular ball bearing. On the contrary since a large amount of preload is required to be applied to the bearing, it is known that the temperature rise of the bearing is increased and thus its life is reduced. In addition, it is difficult to set the initial amount of preload since the premature peeling would be caused with induction

of edge load If the amount of the preload is reduced,

【0036】

In the wheel bearing 24 including the double row conical rollers of this third embodiment, since it is possible to suppress the reduction of the fitting interference, to prevent the generation of the bearing creep, and to securely keep the running stability of vehicle with suppressing the variation of bearing rigidity although the knuckle 2 would be thermally expanded larger than the outer ring itself of the wheel bearing 24 during temperature rise, it is unnecessary to set a large bearing pleload and interference and thus excellent effect can be obtained in improvement of the bearing life.

Fourth embodiment

【0037】

Fig. 7 is a longitudinal view showing a fourth embodiment of the bearing apparatus for a wheel of the present invention. This embodiment is different from the first embodiment only in the structure of the outer ring and thus same reference numerals are used for designating same parts having same functions used in the third embodiment.

【0038】

In this wheel bearing 29, a single annular groove 22 is formed on the outer circumferential surface of the outer ring 30. The annular groove 22 is formed at the axially center of the outer circumferential surface of the outer ring 30 so that it spans the double row outer raceway surfaces 25a. The annular groove 22 is filled with the resin band 23 formed by injection molding PA11 (polyamide11) based heat resisting thermoplastic synthetic resin.

【0039】

Since the resin band 23 of this second embodiment is formed by same manner as that of the first embodiment, it is also possible to suppress the reduction of the fitting interference, to prevent the generation of the bearing creep, and to securely keep the running stability of vehicle with suppressing the

variation of bearing rigidity although the knuckle 2 would be thermally expanded larger than the outer ring itself of the wheel bearing 29 during temperature rise.

Fifth embodiment

【0040】

Fig. 8 is a longitudinal view showing a fifth embodiment of the bearing apparatus for a wheel of the present invention. The same reference numerals are used for designating same parts having same functions used in the previous embodiments.

【0041】

The wheel bearing 31 comprises the outer ring 32, one pair of inner rings 33, and a double row rolling elements (balls) 14 and a pair of annular grooves 34 are formed on the pair of the inner ring 33. These annular grooves 34 are arranged at positions corresponding to the bottoms of the inner raceway surfaces 13a or close to these bottoms, that is load supporting areas. Each of the annular grooves 34 is filled with a resin band 35 formed by injection molding PA11 (polyamide11) based heat resisting thermoplastic synthetic resin. According to the present invention since the knuckle (not shown) is formed of light metal such as aluminum alloy and resin bands 35 having the coefficient of linear thermal expansion larger than that of the knuckle are formed on the inner circumferential surface of the inner ring 33 of the wheel bearing 31 press-fitted into the knuckle, it is possible to suppress the reduction of the fitting interference, to prevent the generation of the bearing creep, and to securely keep the running stability of vehicle with suppressing the variation of bearing rigidity although the knuckle would be thermally expanded larger than the wheel bearing 31 during temperature rise.

Sixth embodiment

【0042】

Fig. 9 is a longitudinal view showing a sixth embodiment of the bearing

apparatus for a wheel of the present invention. The same reference numerals are used for designating same parts having same functions used in the previous embodiments.

【0043】

The wheel bearing 36 comprises the outer ring 12, one pair of inner rings 33, and a double row rolling elements (balls) 14 and resin bands 35 and 19 are provided on the inner and outer circumferential surfaces of the inner ring 33 and the outer ring 12. According to the present invention since the resin bands 35 and 19 have the coefficient of linear thermal expansion larger than that of the knuckle, it is possible to suppress the reduction of the fitting interference, to prevent the generation of the bearing creep, and to securely keep the running stability of vehicle with suppressing the variation of bearing rigidity although the knuckle would be thermally expanded larger than the wheel bearing 36 during temperature rise.

Seventh embodiment

【0044】

Fig. 10 is a longitudinal view showing a seventh embodiment of the bearing apparatus for a wheel of the present invention. This embodiment is different from the fifth embodiment (Fig. 8) only in the bearing structure and thus same reference numerals are used for designating same parts having same functions used in the previous embodiments.

【0045】

The wheel bearing 37 has an outer ring 38, one pair of inner rings 39, and a double row rolling elements (conical rollers) 34. A double row outer raceway surfaces 25a are formed on the inner circumferential surface of the outer ring 25. Annular grooves 34 are formed on the inner circumferential surface of one pair of inner rings 39. These annular grooves 34 are arranged at load supporting areas. Each of the annular grooves 34 is filled with a resin band 35 formed by injection molding PA11 (polyamide11) based heat resisting

thermoplastic synthetic resin. According to the present invention since the knuckle (not shown) is formed of light metal such as aluminum alloy and resin bands 35 having the coefficient of linear thermal expansion larger than that of the knuckle are formed on the inner circumferential surface of the inner ring 39 of the wheel bearing 37 press-fitted into the knuckle, it is possible to suppress the reduction of the fitting interference, to prevent the generation of the bearing creep, and to securely keep the running stability of vehicle with suppressing the variation of bearing rigidity although the knuckle would be thermally expanded larger than the wheel bearing 31 during temperature rise.

Eighth embodiment

【0046】

Fig. 11 is a longitudinal view showing a eighth embodiment of the bearing apparatus for a wheel of the present invention. This embodiment is different from the sixth embodiment (Fig. 9) only in the bearing structure and thus same reference numerals are used for designating same parts having same functions used in the previous embodiments.

【0047】

The wheel bearing 40 has an outer ring 25, one pair of inner rings 39, and a double row rolling elements (conical rollers) 27 and resin bands 35 and 19 are provided on the inner and outer circumferential surfaces of the inner ring 39 and the outer ring 25. According to the present invention since the resin bands 35 and 19 have the coefficient of linear thermal expansion larger than that of the knuckle, it is possible to suppress the reduction of the fitting interference, to prevent the generation of the bearing creep, and to securely keep the running stability of vehicle with suppressing the variation of bearing rigidity although the knuckle would be thermally expanded larger than the wheel bearing 40 during temperature rise.

Ninth embodiment

【0048】

Fig. 12 is a longitudinal view showing a ninth embodiment of the bearing apparatus for a wheel of the present invention. This embodiment is different from the first embodiment (Fig. 1) only in the structure for supporting the inner ring and thus same reference numerals are used for designating same parts having same functions used in the first embodiment.

【0049】

The wheel bearing 3 press-fitted onto the cylindrical portion 5 of the hub wheel 1 is secured with the inner rings 13 being sandwiched via expansion compensating members 41 and 42 between the hub wheel 1 and a shoulder 9 of an outer joint member 8 forming a constant velocity universal joint 7. The expansion compensating members 41 and 42 are formed by PA11 (polyamide11) based heat resisting thermoplastic synthetic resin and have the coefficient of linear thermal expansion ($(8\sim16)\times10^{-5}/℃$) larger than that of the wheel bearing 3, the hub wheel 1 and the outer joint member 8. Thus, similarly to the previous embodiments, due to difference in the coefficient of linear thermal expansion between the knuckle 2 and the wheel bearing 3, it is possible to suppress the reduction of the fitting interference, to prevent the generation of the bearing creep, and to securely keep the running stability of vehicle with suppressing the variation of bearing rigidity although the knuckle 2 would be thermally expanded larger than the wheel bearing 3 during temperature rise.

<u>Tenth embodiment</u>

【0050】

Fig. 13 is a longitudinal view showing a tenth embodiment of the bearing apparatus for a wheel of the present invention. This embodiment is different from the ninth embodiment (Fig. 12) only in the structure of the inner ring and thus same reference numerals are used for designating same parts having same functions used in the ninth embodiment.

【0051】

The wheel bearing 43 has an outer ring 12, one pair of inner rings 44, and a

double row rolling elements (balls) 14. An annular groove 45 is formed on each end face of larger diameter of the inner ring and the annular groove 45 is filled with the resin band 46 formed by injection molding PA11 (polyamide11) based heat resisting thermoplastic synthetic resin. Thus similarly to the previous embodiments, it is possible to prevent reduction of the initially set bearing preload and to improve the assembling efficiency of the wheel bearing apparatus.

【Applicability in industries】

【0052】

The bearing apparatus for a wheel of vehicle can be applied to that having a structure in which the knuckle forming a suspension apparatus of vehicle is formed by light metal such as aluminum alloy having the coefficient of linear thermal expansion larger than that of steel.

【0053】

The present invention has been described with reference to the preferred embodiments. Obviously, modifications and alternations will occur to those of ordinary skill in the art upon reading and understanding the preceding detailed description. It is intended that the present invention be construed as including all such alternations and modifications insofar as they come within the scope of the appended claims or the equivalents thereof.